evidence at the inquiry, and it is interesting to note the grounds given for the various opinions held.

Prof. Kennedy, who is adviser to the Westminster Corporation, advanced the argument that if the 200-volt lamp were really less efficient than the 100-volt, then the consumption of energy per lamp connected to the mains should have steadily increased since 1897, as more and more consumers were changed over to the higher pressure. But this argument is, as Prof. Ayrton pointed out, quite fallacious; if the consumer is supplied with a 200-volt so-called 8 c.p. lamp, which is, in reality (as in an actual case quoted by Prof. Ayrton), only giving a candle-power of 1·8 and is consuming 15·3 watts per candle, it will only consume 28 watts; the consumption of energy is therefore rather less than with a 100-volt 8 c.p. lamp giving its correct candle-power and consuming 4 watts per candle. The consumption of energy per lamp in cases like this goes down, from which Prof. Kennedy would argue that the efficiency has gone up; whereas, as a matter of fact, it has diminished enormously, the effect appearing, not in an increased bill, but in a decrease of light. As a matter of fact, this is the way in which the inefficient lamps show their badness; they do not maintain their correct candle-power and take more watts, but they fall off in candle-power for the same consumption of energy. This was exemplified in the evidence given by Mr. B. M. Drake. Most engineers and lamp-makers call the watts consumed per candle by the lamp its efficiency, though, as a matter of fact, this quantity is a measure of the inefficiency. Mr. Drake prefers to measure the inefficiency by the complaints received per customer, and there can be no doubt that, though unscientific, this is a very good way of getting at an average value. According to this standard, Mr. Drake finds that the 200-volt lamp is much inferior to the 100-volt.

There was not wanting evidence in favour of the 200-volt lamp, but the majority of the experts, certainly in the cases in which the results of actual tests were given, were against it. To take one other instance, Mr. Gunyon, on behalf of the London County Council, gave evidence to the effect that the 200-volt lamp cost more, lasted for fewer hours, and was less efficient than the 100-volt; he gave the results of tests on four different makes of 200-volt lamps, the average consumption of energy in the *new* lamps coming out at 5·4, 4·1, 5·8 and 5·6 watts per candle respectively, the good value (4·1) being for a foreign make of lamps. These figures show that lamp-makers have by no means yet got over the difficulties of the manufacture of the 200-volt lamp which were pointed out by Mr. Byng in a paper read before the Institution of Electrical Engineers three years ago (*Journal* of the Institution of Electrical Engineers, 1898, vol. xxvii. p. 118). That they will ultimately triumph over the difficulties all must hope; that they have satisfactorily done so now cannot, we think, be maintained.

The inferiority of the high-voltage lamp is, however, as we have pointed out, not the only consideration; the change is, without doubt, beneficial to the supply company, and it must, moreover, be remembered that in many cases the change has been all but completely carried out. The Westminster Corporation have only some half a dozen consumers who are still being supplied at the low pressure; the remainder, either through choice, through indifference, or through ignorance of their power to refuse, have submitted to the change. No doubt these few outstanding consumers are an annoyance to the company and a source, possibly, of loss, although the company have raised the price they are charging them to the maximum allowable; yet we cannot help sympathising with the consumer who objects to being compelled to use what he honestly, and with justice, believes to be a worse article.

SEISMOLOGY IN JAPAN.

THE chief interest attached to the publications mentioned below[1] is the fact that while giving us an insight into the attitude taken by the Government of Japan in regard to seismology, they form an important link in the history of the modern development of that subject.

On February 22, 1880, a rather severe earthquake so far excited the curiosity of the inhabitants of Tokyo and Yokohama that, with the object of studying such tremblings, a Seismological Society was founded. This society existed for twelve years and published twenty volumes. The usefulness of its work, attracting the attention of the Japanese Government, led to the establishment of a chair of seismology at the Imperial University, and the organising of a bureau which now controls nearly 1000 observing stations. The next great stimulus that seismology received came from the terrible disaster of October 28, 1891. Ten thousand persons were killed, more than fifteen thousand were wounded, and thirty million dollars' worth of property were destroyed. A comparison of the buildings which remained standing with those which were shattered and those which were utterly ruined indicated that something might be done to minimise such disasters, and to accomplish this, by virtue of an Imperial Ordinance, on June 25, 1892, an Earthquake Investigation Committee was established. This body consists of some twenty-eight members selected from amongst the best-known engineers, architects and men of science in Japan. Two well-known names—Prof. D. Kikuchi and Dr. F. Ōmori—appear as president and secretary. The *modus vivendi*, which can be seen in the Parliamentary Budget, seems to have an annual variation of from 1000*l.* to 5000*l.* Amongst the various investigations which this committee proposed to undertake we find the following: —

To collect documents relating to seismology and volcanology; to draw up a statistical account of seismic phenomena in Japan, such, for example, as might be required by insurance companies whose risks extend to disasters caused by earthquakes; to conduct geological researches bearing upon seismology; to extend our knowledge respecting the nature of earthquake motion; to determine the velocities with which earthquakes are propagated from point to point; to make observations on changes in the vertical and earth "pulsations"; to compare the movements resulting from given earthquakes as recorded on the surface of the earth and at depths which are comparable with the depths to which foundations of buildings may be carried; to extend observations on the variability of magnetic elements, there being reasons to believe that these may hold a certain relationship to seismic activities; to observe changes in temperature at great depths; to determine strength constants for building materials produced in Japan; to measure accelerations and maximum velocities necessary for the shattering, overturning or projection of various bodies, amongst which no less than sixteen types of model houses are specified; to erect buildings specially designed to resist earthquakes; to study the effects of earthquakes on modern construction; and generally the committee undertook to make any investigation which may ultimately result in reducing the loss of life and property which so frequently accompanies violent earthquakes.

Although only nine years have elapsed since this elaborate programme was formulated, every item in it has received serious attention.

From volumes iii. and iv. we see that Profs. Tanabe and Mano have worked at the strength constants of

[1] Publications of the Earthquake Investigation Committee in Foreign Languages. No. 3, pp. 103; No. 4, pp. 141; No. 5, pp. 82; and No. 6, pp. 181. (Tokyo, 1900–1901.)

building materials, and investigated the effects of several earthquakes upon tall chimneys. Dr. B. Koto has handed to the committee twenty-two papers on geological subjects connected with seismology and volcanology. Dr. H. Nagaoka gives a paper of intense interest to all physicists on the determination of the elastic constants of rocks; whilst the well-known professor of seismology, Dr. F. Ōmori, contributes six papers, each of importance to seismologists, and for the most part indispensable to those who have to construct in earthquake countries.

Volumes v. and vi., which contain the analysis of the diagrams of 246 earthquakes observed in Tokyo between July 1898 and December 1899, are entirely from Dr. Omori's pen, and although we may not concur in all the results he sets before us, seismologists in general must thank him for the vast quantity of material which he has brought together and systematised for their consideration. For the earthquakes which originated at great distances from Japan, so far as possible each seismogram has been divided into parts which succeed each other in the following order: "First preliminary tremors," in which waves of 4 seconds period are superimposed upon those of 8 seconds; "second preliminary tremors," with periods of 8 seconds, and accompanied by undulations of 14, 25 and 66 seconds period; "the principal portion" of the earthquake, which is divided into three phases also dependent on period, and finally the "end portion," in which period is fairly regular. The regularity of the terminal vibrations may, as Dr. Ōmori remarks, be explained on the assumption that different portions of the earth's crust have particular periods of free oscillation. The discussion of these various types of earthquake motion is based on the assumption that the waves recorded are *horizontal movements and not tiltings of the ground.*

One observation which led Dr. Ōmori to take this view is that he has obtained seismograms which show that the amplitude of motion depends upon the multiplication ratio of the writing pointers attached to his pendulums, and not upon their sensibility to tilting. In addition to this he points out that if the undulations recorded were due to tilting, then the accelerations involved are such that our sense of feeling should be affected, which is not the case. Since Dr. A. Cancani, in 1893, drew attention to the fact that calculations based on a knowledge of the period, velocity and maximum tiltings of these unfelt undulations led to the conclusion that the inhabitants of the world were raised and lowered two or three feet hundreds of times per annum and had never observed the same, seismologists have regarded with suspicion the elements in the calculations leading to these results. Notwithstanding this, when we have so very much evidence of turbulent wave-like motion in and around epifocal districts, and evidence of repeated tiltings at distances of several hundred miles from the same, it is difficult to escape from the conclusion that similar but slower period movements may be propagated, like a swell upon an ocean, to very distant places, and seismographic pendulums be caused to swing.

Dr. Ōmori has certainly thrown new light upon the nature of the large waves, and it does not seem improbable that investigations carried out upon other lines may, if not completely at least partially, confirm his views.

A more debatable subject touched upon relates to paths followed by earthquake waves through the earth's crust. Because the velocity of the quick period phase of the large waves nearly equals that of local earthquakes, it is assumed that the former, like the latter, are propagated along the surface of the earth's crust, whilst waves which precede them travel at some small depth in the same. Inasmuch as the first preliminary tremors have, at a given station, a duration proportional to the arcual distance of this station from the origin of the earthquake, Dr. Omori thinks it likely that they are transmitted along paths nearly parallel to the surface of the earth, and at a probably constant depth.

Several sections in vol. v. refer to subjects which are not seismic, although they are of great interest to those engaged in certain branches of physical research. For example, references are made to the effect of slight loads upon masonry structures, whilst "oscillations of the ground," whose origin is not seismic, are discussed at some length. That we have for years past been acquainted with movements of pendulums and balances not proper to those of the instruments themselves, which may continue for hours or days, suggests the question whether we are not here being re-introduced to an old enemy in a new dress. Are these movements due to those of the ground or to local movements in the atmosphere? Can Dr. Omori assure us that similar instruments, placed in different rooms or under conditions which are different with regard to temperature and ventilation, behave similarly? If this be the case, then the distinction which has so frequently been drawn between "pulsations" and "air tremors" will be more clearly established. In a stable at Shide "air tremor" effects are, at certain seasons, frequent, whilst at times pendulums with a 15 seconds period will yield diagrams showing that they have been moving regularly with a period of two or three minutes. In an adjoining coach-house these movements are absent, and similar phenomena are common to Tokyo and other places.

What has here been said indicates the nature of the work now in progress in Dai Nippon, a complete account of which is to be found in thirty-two well-illustrated quarto volumes, which, unfortunately for Europeans, are written in Chinese characters. These volumes are with but little doubt one of the greatest store-houses extant of information relating to practical seismology, and as such it is to be hoped that an abstract, or at least a table, of their contents may be published in a European language.

As an example of their value we may select vols. xxii. and xxv., referring to an earthquake which in 1897 devastated North-Eastern India, and cost British investors and taxpayers several millions sterling. The first of these is by Dr. T. Nakamura, an architect, and it contrasts those forms of structure which withstood the effects of the earthquake with those which failed. The second, which treats of railway and bridge construction, is by Mr. T. Koyama, a railway engineer. These gentlemen are two out of four who were sent to India by their Government for the purpose of increasing their own extensive knowledge as to forms of structures most suitable for earthquake countries. On this occasion, as in others, special men were selected for special work, with the result that, not only has Japan profited by disasters of this character, but she has become a teacher of nations in practical seismology, and we, amongst others, may offer her thanks and congratulations on her efforts to save life and property.

J. MILNE.

THE EYE IN THE RECENTLY DISCOVERED CAVE SALAMANDER OF TEXAS.[1]

THE tailed Batrachia have during recent years attained an increased importance zoologically, by appreciation of the fact that in respect to many features in which their living representatives present a simplification of organisation they are retrograde. While but one of them possesses a complete maxillo-jugal arch, none are pentadactyle in both fore- and hind-limbs; and the unexpected has been reached, in the discovery that there

[1] "The Eyes of the Blind Vertebrates of North America," by C. H. Eigenmann (*Trans.* Americ. Microsc. Soc., vol. xxi. pp. 49–60), by C. H. Eigenmann and W. A. Denny (*Biological Bulletin*, Boston, U.S.A., vol. ii. pp. 33–40)